DIAGNOSIS OF A SEVERE HAIL EVENT OVER NORTHEASTERN SPAIN ON 12 JULY 2002

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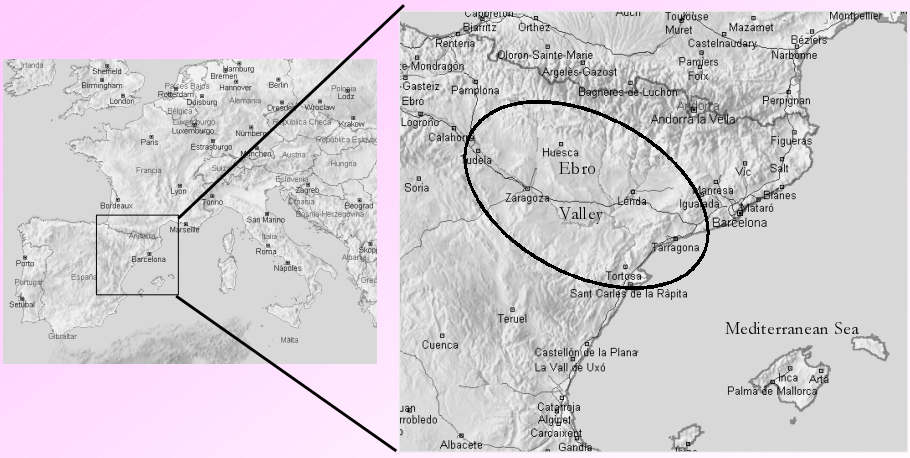
INTRODUCTION AND GEOGRAPHICAL SITUATION OF THE EVENT

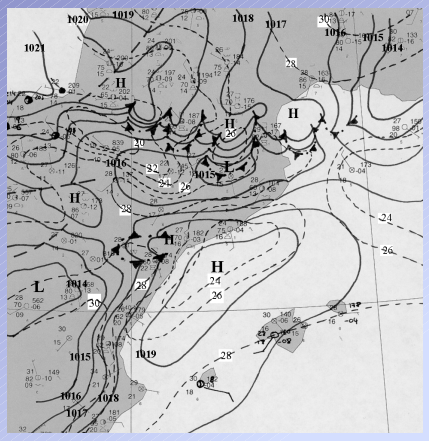


Between 1600 and 2000 UTC, a severe hail event occurred affecting the western part of Lerida province, situated in the middle of the Ebro valley, a closed basin in which air masses penetrate from the WNW or from the ESE.

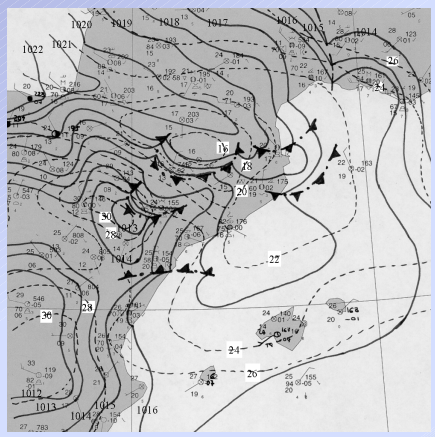
The hail size reached 5 cm and material and economic damage was substantial.

SUBJECTIVE SURFACE ANALYSIS ON 12 JULY 2002

12:00 UTC



18:00 UTC

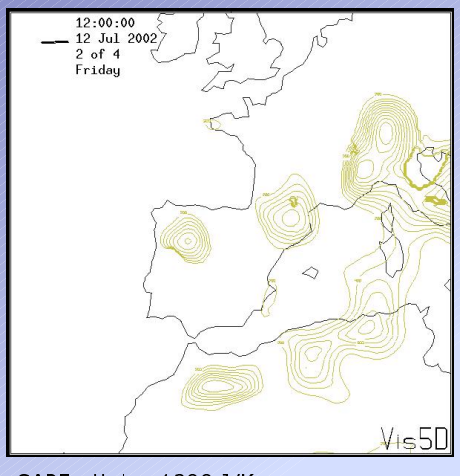


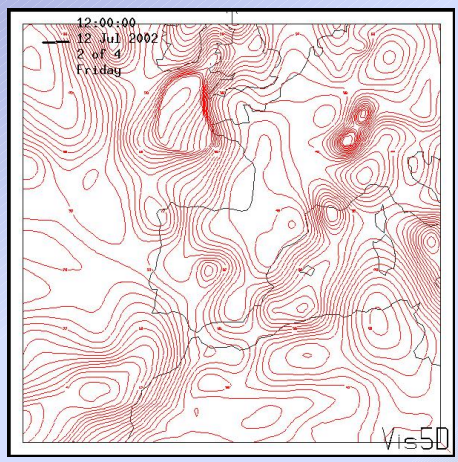
Full lines: Isobars (hPa) Dashed lines: Isotherms (ºC)

NW flow associated with a cold front in the NW of the valley.

Outflows of thunderstorms that generate other ones. All of them are prefrontal thunderstorms.

DIAGNOSIS





CAPE attains 1200 J/Kg

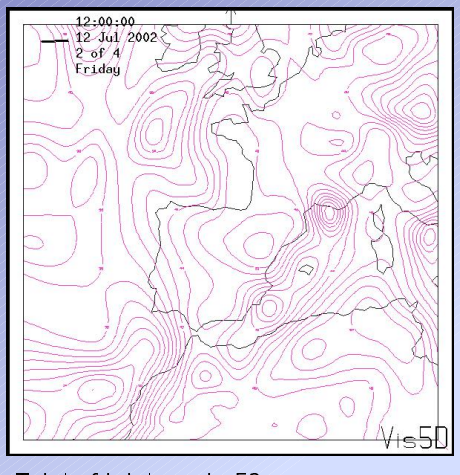
IK index up to 50

Values of CAPE above 1000 J/Kg

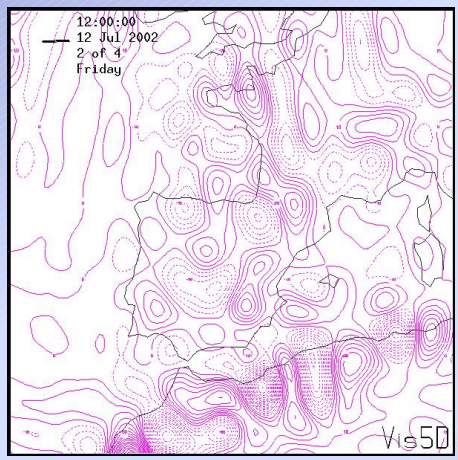
Values of IK above 20

Convection likely

DIAGNOSIS



Total of totals up to 52



Positive values of low level Q vector forcing

Total of totals above 48

Positive values of Q vector forcing

Convection likely

MM5-v3 MODEL

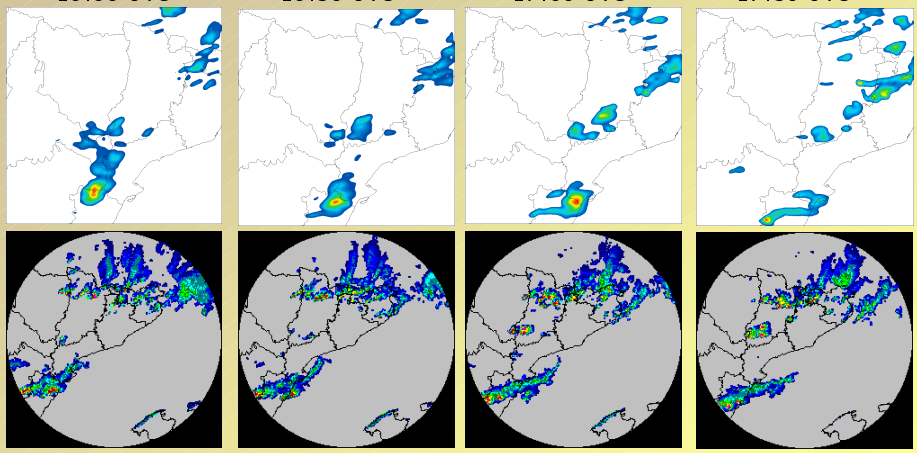
CHARACTERISTICS OF THE SIMULATIONS

- Initial and boundary conditions (updated every 12 hours) come from **NCEP analysis**.
- **Three domains**: 18, 6 and 2 Km, interacting with each other.
- 24 vertical levels.
- The experiments consider a 31 hour simulation (from 12 July at 0000 to 14 July at 0700).

- **Full physics** is used (control experiment).
- **Kain-Fritsch scheme** is used to parameterise convection for first domain, and no convective in the two inner domains.

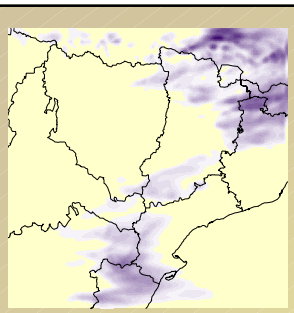
COMPARISON OF THE RAINFALL RADAR IMAGES WITH MM5 OUTPUTS

16:00 UTC | 16:30 UTC | 17:00 UTC | 17:30 UTC

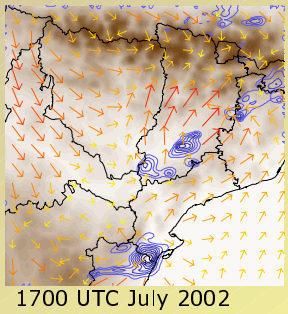


It is clearly observed the similarity between the radar images and the simulation, especially the timing of the event and the geographical position of primary and secondary thunderstorms. The MM5-v3 control simulation is reasonably good.

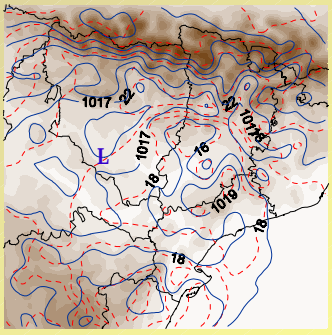
RESULTS FROM THE **CONTROL EXPERIMENT** IN DOMAIN 3



Accumulated precipitation from 0000 UTC 12 July to 0700 UTC 13 July 2002

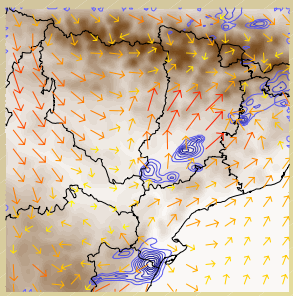


1700 UTC July 2002
Wind field at 900 hPa
Precipitation during previous half hour

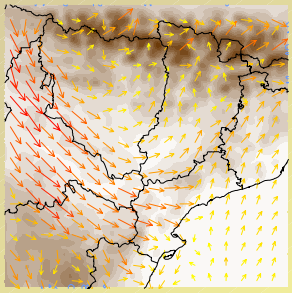


17 UTC 12 July 2002
Sea level pressure (hPa, full lines)
Temperature at 900 hPa (ºC, dashed lines)

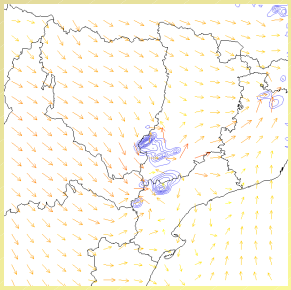
COMPARISON OF THE WIND FIELD AND PRECIPITACION IN LAST HALF HOUR FOR DIFFERENT EXPERIMENTS



CONTROL EXPERIMENT



NO RADIATION EXPERIMENT



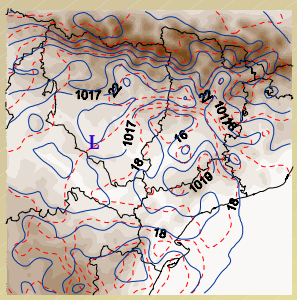
NO OROGRAPHY EXPERIMENT

CE: The precipitation nuclei coincide with the areas where NW winds converge with the breeze from SE. Convective systems are triggered over elevated terrain, where upslope wind systems are induced by diurnal forcing.

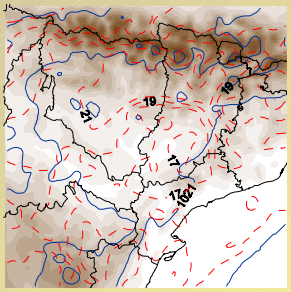
NRE: NW flux dominates most of the areas and there are no breezes. There are not convergence zones in the Ebro valley so precipitation is not generated.

NOE: The breeze is stronger than in CE owing to the absence of mountains so the convergence is more important and the precipitation in low terrain areas is more intense. As expected, precipitation in the Iberic System and Pyrenees mountains is diminished.

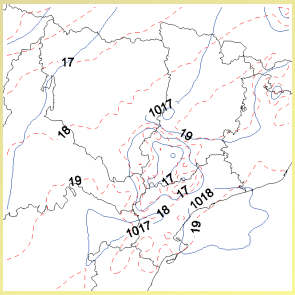
COMPARISON OF THE SEA LEVEL PRESSURE AND TEMPERATURE AT 900 hPa FOR DIFERENT EXPERIMENTS



CONTROL EXPERIMENT



NO RADIATION EXPERIMENT



NO OROGRAPHY EXPERIMENT

CE: Sea level pressure presents a relative low over the Ebro valley (L), which coincides with a centre of high temperature. It could be a thermal low.

NRE: The mesolow that appeared in CE over the Ebro valley is not present now, what reasserts the hypothesis of a thermal origin for the low.

NOE: Presents a high pressure center in an area with low temperatures (consequence of the convective cold pools).

COMPARISON OF THE ACCUMULATED RAINFALL FOR THE DIFERENT EXPERIMENTS

CONTROL EXPERIMENT | NO RADIATION EXPERIMENT | NO OROGRAPHY EXPERIMENT

CE: Convective systems are triggered over elevated terrain, where upslope wind systems are induced by diurnal forcing. Secondary thunderstorms are generated in the center of the Ebro valley, supported by the thermal mesolow and convective outflows from the first convective systems.

NRE: With no diurnally forced upslope winds and thermal mesolow in the centre of the Ebro valley, precipitation is not generated.

NOE: Precipitation in low terrain areas, but much less precipitation in the Iberic System and Pyrenees mountains.

CONCLUSIONS

- The CE simulation reproduces accurately the observed situation.
- The NRE experiment reveals the thermal origin of the mesolow.
- The NOE experiment demonstrates that the position of the precipitation areas is due to the topographic configuration of the Ebro valley.

- This study suggests that the synoptic background flow at upper levels is fundamental in any convective situation over this area.
- The radiation effect plays an important role by modifying the surface flows due to the generation of thermal mesolows, which permit the incoming of wet air from the Mediterranean Sea.
- The orography focalizes the low-level wind convergences.
- The high values of instability indexes have been an important factor in the severity of the hail event.